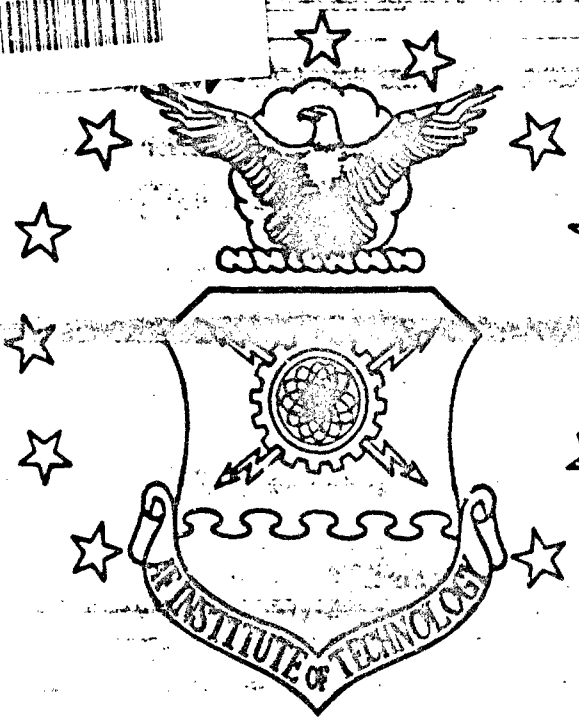

DEPARTMENT OF THE AIR FORCE

AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/GEM/DEV/91S-2

IMPACTS OF BIOMONITORING REQUIREMENTS ON DOD WASTEWATER TREATMENT FACILITIES

THESIS

James R. Brady
Captain, USMC

AFIT/GEM/DEV/91S-2

The views expressed in this thesis are those of the authors and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

AFIT/GEM/DEV/91S-2

IMPACTS OF BIOMONITORING REQUIREMENTS ON DOD WASTEWATER TREATMENT FACILITIES

THESIS

Presented to the Faculty of the School of
Systems and Logistics of the
Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Engineering Management

James R. Brady, B.S.
Captain, USMC

September 1991

Acknowledgements

I wish to thank my thesis advisor, Lt Col Mark Goltz, for his guidance, expertise, and patience in assisting me with this project. His knowledge in the environmental field has been an inspiration.

I am also deeply indebted to the respondents at the various bases contacted. Their patience with my questions, and lack of knowledge in some cases, is much appreciated. Without their willingness to participate, this research effort would not have been possible.

Finally, I especially want to thank my wife Susie for all the time she spent taking care of Ryan while duty, and the thesis, called.

James R. Brady
Capt USMC

Table of Contents

List of Tables

Abstract

Legislative emphasis on reducing the toxicity of wastewater effluent has resulted in increasingly sophisticated methods of determining toxicity. The purpose of this research project is to assess the impacts on DoD wastewater treatment facilities of one new monitoring method, biomonitoring.

Biomonitoring has impacted DoD wastewater treatment facilities, however not to the degree anticipated. For bases that have been impacted, cost of contracting the tests is the primary problem associated with biomonitoring.

Many bases have not been impacted because wastewater reuse has negated the need for discharge permits, and the inherent monitoring requirements. Bases subject to biomonitoring should assess water reuse as a means of wastewater disposal. Additionally, other bases have not as yet had biomonitoring requirements imposed on them. It is recommended that these bases prepare for future biomonitoring requirements by having their effluent tested to determine toxicity in anticipation of biomonitoring implementation by the states.

Because the government can conduct biomonitoring tests at an estimated 50 percent of the contracted costs, it is also recommended that the Air Force assess the feasibility of expanding the capabilities at Brooks AFB.

It is further recommended that all DoD facilities audit all processes contributing toxic materials to base wastewater flows to determine if pollution prevention measures can be initiated.

IMPACTS OF BIOMONITORING REQUIREMENTS ON DOD WASTEWATER TREATMENT FACILITIES

I. Introduction

General Issue

On October 18, 1972, the United States Congress passed the Federal Water Pollution Control Act (18:896), commonly known as the Clean Water Act (19:1566). The primary objective of this Act is to "restore and maintain the chemical, physical, and biological integrity of the Nation's [sic] waters" (18:815). Provisions in the Act affect all dischargers of pollution into the nation's waters, from publicly owned treatment works, to private industry, to federal facilities. It states that by 1 July 1977, all point sources of pollution, other than Publicly Owned Treatment Works (POTWs) will have effluent limitations which will require the use of "best practicable control technology currently available" (18:845), and all POTWs will have imposed effluent limitations based on secondary treatment technology (18:845). It goes on to direct that each federal department or agency

> (1) having jurisdiction over any property or facility, or (2) engaged in any activity resulting, or which may result, in the discharge or runoff of pollutants, and each officer, agent, or employee thereof in the performance of his official duties, shall be subject to, and comply

> with, all Federal, State, interstate, and local requirements, administrative authority, and process and sanctions respecting the control and abatement of water pollution in the same manner, and to the same extent as any nongovernmental entity. (18:875; 19:1598)

The basic procedure for regulating the effluent discharges was established in section 402 of the Act, with the National Pollutant Discharge Elimination System.

Under provisions of the Act, the National Pollutant Discharge Elimination System (NPDES) indicates that the Administrator of the Environmental Protection Agency (EPA), or any state having approval by the EPA to administer the NPDES program, may "issue a permit for the discharge of any pollutant or combination of pollutants" provided that the discharge meets all applicable requirements (18:880). The Act also states that the permit will be for a fixed term of not longer than five years (18:881).

Provisions of the NPDES program are contained in the Code of Federal Regulations. Subpart C of Part 125 contains the conditions for all permits under the program. This regulation states that each facility with a permit

> must comply with all conditions of this permit. Any noncompliance constitutes a violation of the Clean Water Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modifications; or denial of a permit renewal application. (6:88)

Included in the permit are requirements for monitoring the effluent, and record keeping. In particular, monitoring must be in accordance with test procedures as specified in

the Code of Federal Regulations (CFR), "unless other test procedures have been specified in the permit" (6:90). In essence, each facility with a discharge permit that expires every five years (or less) could be subject to changes in the requirements of the permits, be they levels of pollutants or methods of testing; the facility must comply with those requirements or face legal or administrative action.

Inherent in the Act itself are directions to the EPA Administrator to develop new ways of identifying and measuring the effects of pollutants on the environment (18:820). The impacts of such newly developed methods are written into discharge permits as they come up for renewal. William H. Parker III, former Deputy Assistant Secretary (Environment), Department of Defense, discussed some of the budgetary burdens on Department of Defense (DoD) facilities with members of Congress. In his testimony, Mr. Parker stated that:

> Military Construction (MilCon) and water pollution abatement projects continue to be needed as a result of new laws and regulations by the EPA and the inability of aging plants to comply with tough new standards.
>
> Increasing regulations, more stringent permit requirements, and increasing interest in estuaries will continue to strain DOD's aging wastewater treatment facilities and will necessitate construction of new and/or improvements to existing facilities. (5:192)

Specific Problem

In 1987, Congress passed further amendments to the Federal Water Pollution Control Act. These amendments, referred to as the Water Quality Act of 1987, "established toxics control as the water quality agenda of the 1990's" (14:304). Included in this Act are the directions for the Administrator of the EPA to "develop and publish information on methods for establishing and measuring water quality criteria, including biological monitoring and assessment methods" (20:39). It goes on to say that there should be no delay in the use of effluent limitations or other conditions in NPDES permits utilizing these methods (20:39). This basically indicates that biomonitoring should be incorporated into NPDES permits as soon as practicable.

Definition of Biomonitoring

As stated by Matthews, et al., biomonitoring is defined as "the systematic use of biological responses to evaluate changes in the environment with the intent to use this information in a quality control program" (13:129). For the purposes of this paper, biomonitoring can be defined as a comprehensive surveillance technique to assess the overall biological impact of discharging treated wastewater and/or pollutants into an aquatic environment.

Research Objective

The purpose of this research is to assess the impacts of new biomonitoring requirements on DoD wastewater treatment facilities.

Investigative Questions

The following questions will address the specific problem:

1. Do DoD facilities have the capabilities, such as trained personnel, and approved laboratories and test facilities, to conduct biomonitoring in accordance with the regulations?

2. Will it be more cost effective to run the tests within the Department of Defense, or to contract the testing to civilian laboratories?

3. What problems will sample taking create?
   3.a. Will personnel need to be trained?
   3.b. What special shipping, handling and storage requirements will be needed?
   3.c. Will time constraints between sample taking and testing create problems?

4. Can current DoD treatment facilities produce effluent capable of passing biomonitoring tests, or will modifications be required?

Methods used to answer these questions, and how the data will be analyzed are addressed in Chapter III.

II. Literature Review

Federal facilities are required to comply with all environmental laws and regulations. Among these laws are the Water Pollution Control Act as amended by the Clean Water Act of 1987. Federal facilities have had some difficulty complying with these laws in the past, and it is presumed that revisions to the laws, and increasingly restrictive regulations pertaining to these laws, will continue to cause compliance problems with federal facilities. In order to provide a framework for possible difficulties resulting from biomonitoring, this literature review will indicate some of the specific problems encountered by DoD and other federal facilities in complying with the Clean Water Act. This chapter will also review some of the literature on biological monitoring, a water quality monitoring technique that all wastewater or pollutant dischargers may be required to implement in order to continue discharging wastewater into the nation's surface waters.

DoD Environmental Compliance Problems

Keeping up with ever-changing regulations is no small task for private industry or federal facilities. As Col Stephen G. Termaath, former Assistant for Environmental Quality, Office of the Deputy Assistant to the Secretary of the Air Force, pointed out:

> Environmental professionals face the impossible task of remaining current on an explosion of environmental regulations. Since 1971, the Environmental Protection Agency has produced over 2,000 new rules. In 1986 alone, 8,500 pages of new regulations were produced. EPA's share of the Code of Federal Regulations can be found in a dozen or more volumes. Technical guidance manuals that supplement these rule are measured in linear feet. The sheer volume and increasing rate at which regulations are promulgated place great stress on the management of environmental programs. State programs to which we are also subject have grown in a similar fashion. While the private sector must comply with the same standards, few private sector companies attempt to operate in all 50 states. (5:223)

While this is by no means an excuse for environmental noncompliance by DoD installations, it is an indication of the breadth of environmental regulations with which facilities must comply.

DoD Compliance with the Clean Water Act

Background. In accordance with the Clean Water Act, every facility must obtain a permit restricting the amounts of specific pollutants that may be discharged. Any federal agency that has cognizance over an activity or facility that discharges pollutants is required to comply with all requirements, federal through local, that govern the control of water pollution (9:10). The permits, issued under the NPDES program, are legally enforceable documents. Along with the limits on pollutants, they establish requirements for reporting results to the appropriate regulating agency indicating actual discharge concentrations recorded at specified monitoring points (9:12). The regulating agency

is either the EPA or a state with authority granted by the EPA to administer the NPDES program within its borders (9:2). Under the program, the facility's operations are monitored by the permit holder, who submits periodic reports on their own compliance with the permit. The regulating agency reviews the reports, tracks the compliance, and inspects the facility at least annually. The regulators must take "timely and appropriate enforcement actions" once significant noncompliance at the facility has been identified, and before this significant noncompliance lasts for two consecutive quarters (9:3). Significant noncompliance is defined as "instances of severe and chronic violations of pollutant limits or reporting requirements" (9:3). Federal facilities have had problems with significant noncompliance and other aspects of the NPDES program.

Problems. Facilities receiving permits are classified under the system as either major or minor dischargers, based on the risk posed to the environment. Major permittees are those with the greatest potential to adversely affect water quality (9:2). A Government Accounting Office (GAO) report on water pollution and federal facilities found that during FY 1986 and FY 1987 an average of 20% of 150 major federal facilities were in noncompliance with NPDES program requirements during any given quarter. 40% of those in noncompliance were in violation for a year or longer, and

75% were in significant noncompliance (9:3,24). Roughly two-thirds of this noncompliance rate was due to effluent violations, with the remaining noncompliance due to reporting or other violations such as violating compliance schedules, construction milestones, and special report deadlines (9:23,25). The report also indicates that the rate of noncompliance with program requirements for federal facilities was nearly twice that of nonfederal facilities (9:3).

These compliance problems have not gone unnoticed by Congress. Representative Richard Ray, Chairman of the Environmental Restoration Panel of the House Armed Services Committee, indicated that DoD is having more problems complying with the Clean Water Act (CWA) than other industrial and municipal facilities. Chairman Ray further pointed out that after the panel staff looked into a CWA problem at the Marine Corps Supply Depot in Albany, Georgia, he got the impression that CWA problems were getting less attention than other environmental compliance issues, such as hazardous waste (5:67).

Representative George Miller of California also indicated that the failure of DoD facilities to comply with the Clean Water Act is an embarrassment to congressmen because the government is requiring private industry to comply with that act, costing tens of millions of dollars, yet the Department of Defense is not complying (5:168-169).

Congressman James Hansen of Utah summarized Congress' impatience with DoD on this issue with the following statement:

> DoD has to recognize that its words must be translated into deeds. For the past several years, I have repeatedly heard DoD refrain that it is working the environmental problem and that Congress should be patient and hold off on new legislation. The problem is that DoD has failed to deliver on many of its promises... DoD cannot identify environmental compliance requirements or funding levels in the budget requests, even though we are given assurances that the money will be available... someone has to get the message back to the DoD leadership and the comptroller that environmental compliance problems must be taken more seriously. (5:137)

The reasons for noncompliance problems within DoD are numerous. Col McAlear, Special Assistant for the Environment, Office of the Assistant Secretary of the Army, Installations and Logistics, indicated to the panel that reasons for noncompliance in 42 Notices of Violation (NOVs) during FY 1988 included an aging infrastructure that is incapable of meeting more stringent effluent criteria, operators that were not always trained or supervised properly, and a lack of operators that existing grade structures called for or operators that lacked the competence to operate some modernized facilities (5:203). The GAO report points out that common causes for violations are malfunctioning equipment, discharges to treatment facilities that hindered the treatment process, routine maintenance that interrupted the process, and laboratory and sampling errors. The federal budget process and procurement

procedures were also cited as underlying causes that impact federal facilities' ability to comply (9:28,32).

Funding. As of 1990, $40 billion has been spent on a national scale for cleaning the nation's waters since the passage of the Federal Water Pollution Control Act in 1972. An estimated $60-$70 billion will be required to meet the goals of the Act as amended in 1987 (11:1122). At the DoD level, several budget problems were indicated in Chapter I. In addition, Mr. Parker, Deputy Assistant Secretary of Defense (Environment), pointed out that many of the treatment facilities in DoD are more than 20 years old and plans will be needed for their replacement (5:192). As Mr. Parker stated:

> Environmental compliance is the responsibility of the installation commander. Therefore, the funding for the repair of a treatment plant must come from the installation's operation and maintenance budget... DoD will have to work closely with federal and state regulators to insure that adequate timeframes are incorporated into the permanent requirements to allow for funding of these [new and/or improved] treatment systems and thus avoid significant noncompliance problems in the future. (5:192)

Funding levels for wastewater improvement in the FY 1990 DoD budget were approximately $26.6 million. $1.27 billion was spent in wastewater treatment improvements between 1974 and 1989 by DoD (5:229-230).

Anniston Army Depot and the Norfolk Naval Shipyard are two examples where significant funding requirements were needed for corrective actions to bring these facilities into

compliance with their permits. These facilities were not in compliance for at least four quarters each during fiscal years 1986 and 1987. Of 52 corrective actions needed at the Navy base, and 20 required at the Army depot, 31 and 55 percent respectively required a year or longer to complete. This was due to contracting for design and construction, large-scale repairs, and/or new equipment (9:31).

While funding is part of the problem of compliance with the CWA, it is not the only problem. The GAO found that 84 percent of the corrective actions needed at seven facilities singled out for case studies did not require funding that needed lengthy approval procedures (9:32).

Low Priority. The Government Accounting Office feels that the primary reason for noncompliance is the low priority given to clean water regulations by federal facilities (9:3). In addition to the complications listed above, funding was also cited as a possible explanation for this low priority. Conflicting missions compete for limited funding, and environmental matters are not always viewed as being as important as the facility's primary mission (9:39). Some courses of action have been proposed by the GAO and DoD to help resolve this problem.

Solutions. The GAO concluded that the EPA and state regulators could raise the priority level that federal facilities give to complying with water standards by using the legal and administrative actions as authorized by the

regulations (9:3). These include both informal and formal measures ranging from telephone calls and compliance agreements, to administrative orders and judicial action (9:14). One reason formal enforcement actions have not been utilized to the extent possible by the EPA in the past is their attempt to rely on authorized states to take enforcement action. The states, however, have also failed to take enforcement action in some cases. Among the states' reasons for failing to take formal actions were time delays in determining the causes of violations, and allowing federal agencies time to complete lengthy construction projects to correct the problems (9:51-52). The GAO feels that increasing the enforcement actions against federal facilities will improve compliance with regulations (9:66).

DoD does not see increased enforcement action as the solution. One solution posed by DoD includes improved operator training and operator certification for modernized facilities to reduce errors resulting in noncompliance (5:192). Nancy Stehle, Deputy Director, Environment, Office of the Assistant Secretary (Shipbuilding and Logistics), Department of the Navy, also pointed out that closer coordination and improved communication between the regulators and permit holders are needed to improve compliance (5:218).

The recently issued Technical Support Document For Water Quality-based Toxics Control by the EPA is a step

forward in improved communication between the regulators and the regulated. It provides information about various approaches to toxics control, including biomonitoring, as well as background and supporting information about NPDES permit requirements.

The EPA and NPDES Permits

Water pollution control is carried out by the EPA through various management programs including the National Pollutant Discharge Elimination System program. States are able to take over the NPDES program within their boundaries with the EPA ensuring that federal regulations are adhered to. Because states are allowed to establish their own water quality standards, and because the EPA's function is merely to ensure that each State program is technically sound and fully implemented, toxics control programs may not be uniform nationwide (8:xxiii). The EPA has however standardized the approach that states should take when instituting their water quality control programs.

One aspect of this standardization by the EPA is their "integrated approach" to toxics control. This strategy includes the use of chemical specific limits, whole effluent toxicity testing (biomonitoring), and biological criteria/ bioassessment and biosurvey analyses (8:1). As stated in the Technical Support Document:

> Taken together, chemical, physical, and biological integrity define the overall ecological integrity of an aquatic ecosystem. Regulatory agencies

> should strive to fully integrate all three approaches since each has its respective capabilities and limitations. (8:20)

These strengths and weaknesses, identified in the document, along with "overlapping attributes, sensitivities, and program applications" (8:22) dictate the use of the integrated approach. Additionally, success with one method in testing an effluent sample, e.g. complying with all chemical specific criteria, should not overrule the results of, or justify not using, another method such as biomonitoring (8:22). Again, determination of the method or methods to be used is left up to the state or regulatory agency.

The use or uses to be made of a body of water are particularly important in establishing water quality standards by the state. Once attainable uses are determined, criteria and implementation procedures are set to protect the water quality, and attain/maintain the designated use(s) (8:29). In establishing the criteria for water quality protection, the EPA encourages the use of both numeric and narrative criteria. Narrative criteria for toxics control can be very broad statements such as the following: "All State waters must, at all times and flows, be free from substances that are toxic to humans or aquatic life" (8:31). Such broad statements can be the basis for requiring biomonitoring of wastewater effluent. There is however a regulatory exception to requiring whole effluent

toxicity testing (biomonitoring); 40 CFR 122.44(d)(1)(v), as written by the EPA, states that:

> Except as provided in this subparagraph, when the permitting authority determines,... that a discharge causes, has the reasonable potential to cause, or contributes to an in-stream excursion above a narrative criterion within an applicable State water quality standard, the permit must contain effluent limits for whole effluent toxicity. Limits on whole effluent toxicity are not necessary where the permitting authority demonstrates in the fact sheet or statement of basis of the NPDES permit, using the procedures in paragraph (d)(1)(ii) of this section, that chemical-specific limits for the effluent are sufficient to attain and maintain applicable numeric and narrative State water quality standards. (8:48)

Thus wastewater dischargers, including DoD facilities, may be exempt from biomonitoring at the discretion of the state if the above conditions are met.

Regardless of this "exception", biomonitoring is becoming a major factor in water pollution control.

Biomonitoring

Background. In addition to the legal requirements indicated in Chapter I, there are several reasons that biological monitoring should be conducted to assess the impacts of discharging wastewater and pollutants into the nation's waters. NPDES permits, as traditionally written, specify levels of pollutants that may be discharged. Chemical-specific limits, however, do not consider the overall effects of the discharge on the ecosystem to which it is entering (4:422). As Diane Blum and R. Speece stated:

> Worldwatch Institute estimates that there are 70,000 synthetic chemicals in everyday use, with between 500 and 1,000 new ones added to the list each year. But for approximately 79% of the chemicals in commerce, no information on their toxic effects is available. (1:284)

Detection methods for chemical-specific limits cannot measure many toxic compounds and the methods fail to account for the interaction of chemicals and the harmful effects produced (21:7). Merely knowing the concentration of a chemical or pollutant will also not likely produce useful management information, since it is the combination of toxicants, ambient water quality, and organisms present that will dictate the harmful effects to the ecosystem (3:1179).

John Cairns, Jr. and David Oros spelled out some circumstances when biomonitoring should be used: 1) if the concentration of a chemical is very close to that concentration that will adversely impact organisms or ecosystems; 2) if changes in the ambient surroundings will affect the system even when chemical concentrations are constant; 3) when pollutants in the stream may interact with discharged pollutants; 4) if the ecosystem is fragile; 5) when properties of the waste are variable; and 6) when the accuracy of laboratory tests is in question (4:423). Biomonitoring must also be used when a NPDES permit held by a discharger has this method of testing as a requirement.

Permits. Specifics of the biomonitoring requirements being written into renewed NPDES permits include sampling locations and frequencies, and test organisms and

procedures. The requirements include testing discharges from treatment facilities as well as runoff from drainage ditches and streams, which may flow only during periods of heavy rainfall (12:220). This will provide information about the interaction of receiving waters and the waste streams entering them (4:422-423). Permits also include requirements to submit plans to control any toxicity identified by biomonitoring (21:10).

Testing. There are two primary types of biomonitoring tests being written into permits: acute and chronic. Acute tests measure the mortality rates of certain species of organisms (water fleas or fathead minnows) in samples of the wastewater. Chronic tests measure growth, reproduction, and survival rates of organisms in various concentrations of the water sample (12:221). The objective of chronic tests is to determine the highest "safe" or "no-effect concentration" of the effluent. This is the sample with the highest concentration that produces no effect on the organisms (7:2). The water used to dilute the waste sample is either a standard dilution water, typical for most NPDES applications, actual water from the receiving body, or water with characteristics similar to the receiving water. The sample of wastewater to be tested should be used within 36 hours of taking the sample (7:3-4). Detailed statistical analyses are used to determine the concentrations that indicate various levels of adverse effects on the organisms.

Discharge Limits. Discharge limits established in the permits are based on the lowest concentration of the mixture of the discharge and the receiving body of water that causes "unacceptable toxic effects on the most sensitive test species" (21:9). The mixture is that occurring between the amount of waste or pollutant discharged and the amount of flow in the receiving body at low flow conditions (21:9). In essence, a treatment facility must produce effluent with a level of all toxics low enough such that when this effluent mixes with the amount of water flowing in the receiving body at low-flow conditions, the resulting concentration of toxics in the mix will not adversely affect the most sensitive organisms.

EPA tests have shown that biological testing can reveal wastewater discharges that would comply with chemical-specific limitations in permits but would be toxic to living organisms or ecosystems (10:755).

Successes of Biomonitoring. Chemical-specific tests of the discharge of a chemical plant in Louisiana indicated that no harmful materials were present in toxic concentrations. A biomonitoring test on a 1 percent solution of the discharge resulted in mortality to 100 percent of the organisms in the test. Another biomonitoring test on the Ottawa River in Ohio indicated that a wastewater treatment plant was the primary source of toxicity in the river, when it was originally presumed to be either a

petroleum refinery and/or a chemicals manufacturer. There were no previous indications through chemical-specific tests that the treatment plant was discharging toxic effluent (21:8).

These examples raise some questions about the treatment systems that have cost billions of dollars to construct, such as 1) can they eliminate the toxic effects of the waste being treated; 2) will the toxics in the waste damage biological treatment processes; and 3) how will the toxics affect the aquatic environment when discharged? (1:284).

Problems with Biomonitoring. Application of biomonitoring requirements to Publicly Owned Treatment Works (POTWs) could result in many of these facilities being in noncompliance and facing enforcement action (10:755). Uncontrollable factors that could affect the biomonitoring tests on POTWs include the potential for receiving many more unknown toxicants than facilities treating industrial waste of known components, improper and/or illegal dumping of pollutants into the waste stream being treated, and variable dilution effects. Chemical analysis for a specific chemical substance is also easier, less expensive, and can be performed at much greater frequencies than biomonitoring tests (10:756,759). Finally, as Gene Michael, et al. have pointed out:

> ...toxics control is poorly understood and existing POTWs have not been designed to treat toxics. Moreover, it is impossible for POTWs to completely control access to collection systems;

> therefore, POTWs become liable for toxic discharges instead of the actual perpetrators... Unfortunately, the technology required to detect and treat toxics is far beyond society's ability to produce them. (14:304)

Although nearly 90 percent of the federal facilities that treat waste are classified as industrial waste treatment facilities, with the remaining being domestic sewage treatment plants (9:2), many of the above mentioned problems for POTWs could apply to these facilities. The EPA has, however, developed an alternative to the cut and dry 'fail a biomonitoring test and be out of compliance' situation.

Toxicity Reduction Evaluations. NPDES permits can have written into them the requirement to conduct a Toxicity Reduction Evaluation (TRE) when a discharger fails biomonitoring tests. The TRE is a process to pinpoint the problem area or the cause of exceeding toxicity limits (8:114). The EPA has developed guidance documents for conducting TREs that "recommend a systematic, stepwise approach that eliminates the possible causes or sources of toxicity until a solution or control method is determined" (8:114-115). This approach avoids the pitfall of simply throwing money at the problem to correct it, and provides a logical basis for selecting an adequate control solution (8:114).

The agency issuing the permit has the responsibility to notify a discharger if a TRE is required. More frequent toxicity testing may also be required when there is a

violation, however this is to provide information to determine what action should be taken, not to simply verify earlier test results. On this matter, the EPA has indicated that:

> If the permit has a limit for whole effluent toxicity, then generally, the permit should not include any specific conditions for accelerated toxicity testing or for triggering a TRE or some other action (e.g. exceedances in two consecutive tests or in any three out of five tests). CWA [Clean Water Act] Section 309 requires that any single violation of a permit limit may be subject to enforcement... Accelerated monitoring should only be used to assist in this professional review to determine what, if any, enforcement response is necessary, including the need for the permittee to conduct a TRE. It will be necessary for the Region or State regulatory authority to determine this on a case-by-case basis. (8:118)

Thus it is evident that the states do have some latitude with accelerated testing requirements and TRE initiation. Additionally, Ms. Margaret Heber of the Enforcement Division, U.S. EPA, has indicated that states and EPA regions also have some latitude in requiring TRE's in lieu of, or in conjunction with, Notices of Violation.

Stormwater Permits and Biomonitoring. The discharge of stormwater into the nation's waters has also come to the forefront of water quality management. The EPA has recently published regulations regarding applications for NPDES permits for such discharges. These permits will be classified as either municipal or industrial. The Department of Defense can expect to be affected by the industrial permits since operations such as airports and

other transportation facilities, construction sites of over five acres, and wastewater treatment plants treating more than one million gallons per day are among those requiring permits (15:53;55). The new regulations deal mainly with the permit applications and required deadlines for submitting the various parts of the applications. Little guidance is provided by the Clean Water Act or the regulations pertaining specifically to pollution control of stormwater runoff (2:64). Best available technology and best conventional pollutant control technology will be required for pollution control by industrial permittees; these terms translate to "maximum economically achievable pollution reduction", and apply to conventional and priority pollutants (15:54). Biomonitoring could come into play with these permits since water-quality based control of pollution may be required by the permitting authority if necessary (15:54). Once this process of getting stormwater sources of pollution permitted has been accomplished, future guidance and regulations regarding pollution control can be expected (15:56). This is similar to the way pollution control technology for point sources has evolved since the initial implementation of the NPDES program.

Conclusion

This review has attempted to highlight some of the problems encountered by DoD, and federal facilities in general, in complying with clean water regulations. It will

require the efforts of both regulators and facilities to continue the improvement of our nation's waters and the compliance of treatment facilities. One method of determining the overall effect of toxic substances on the nation's waters is biomonitoring. There are both positive and negative aspects to this monitoring technique that must be considered as implementation occurs. As Gene Michael, et al. have stated: "Toxics control is a new and uncharted area in which mutual effort by dischargers and regulators will be required to achieve success" (14:309).

III. Methodology

Overview

This chapter will review the problem area being researched, and discuss the method used to solve the problem. The basic areas to be investigated are restated, and the selection of the population and the sample of personnel interviewed are discussed. Finally, the method used to analyze the data is addressed.

General Issue

Environmental laws and regulations which incorporate new technologies require Federal agencies to implement new procedures to ensure continued environmental compliance. As new testing, monitoring, and control regulations become increasingly sophisticated and restrictive, new economical, technological, and logistical burdens are placed on Federal facilities that must comply with these regulations.

Specific Problem

National Pollutant Discharge Elimination System (NPDES) permits for discharging treated wastewater (effluent) into surface waters expire every five years at most. A new method of testing the effluent for toxic effects on the receiving waters, called biomonitoring, is being required by some permitting authorities as the permits are renewed. The purpose of this research is to assess the impacts of new

biomonitoring requirements on DoD wastewater treatment facilities.

Investigative Questions

The following questions will address the specific problem:

1. Do DoD facilities have the capability to conduct biomonitoring?

2. Will it be more cost-effective to run the tests within the DoD or to contract the testing to civilian laboratories?

3. What problems will sample taking create?

4. Can current DoD treatment facilities produce effluent capable of passing these new tests?

Population and Sample

In order to effectively answer the investigative questions, and arrive at a solution to the specific problem, the population from which a sample will be drawn is defined as personnel who are knowledgeable about operations of wastewater treatment facilities, and who are knowledgeable about the requirements of biomonitoring. The sample of people to be interviewed will include operators and managers of DoD wastewater treatment facilities that are currently operating under NPDES permits requiring biomonitoring, and those of facilities that will be required to biomonitor in the future. This will indicate actual problems encountered and problems anticipated by DoD facilities. This portion of the sample will include managers/operators of wastewater

treatment facilities in the United States Air Force and the United States Marine Corps. Only facilities that treat their own wastewater will be contacted. Bases that use regional connections to local publicly owned treatment works are excluded from the population because they are not impacted by NPDES permits and their monitoring requirements. Tables B.1 and B.2 in Appendix B of a water and wastewater treatment inventory done as a thesis project by Capt Vincent E. Renaud, USAF in 1987 will serve as the basis for selecting Air Force bases to contact (16:59-63). These tables indicate which Air Force bases treat their own wastewater and which use regional connections. Marine Corps bases will be contacted to determine if there are any intra-service differences in impacts experienced due to biomonitoring. The U.S. Army and U.S. Navy will also be contacted to assess problems with biomonitoring at the service level. Environmental Protection Agency personnel will be queried to substantiate and expound on the problems identified. DoD laboratories certified by the EPA to conduct biomonitoring will be contacted to determine what services are available and what problems have been encountered.

Data Collection and Analysis

Answers to the investigative questions will be obtained through interviews of personnel in the sample. Specific measurement questions asked of the respondents are included

in Appendix A. Telephone interviews will be used due to the geographical spread of the bases to be contacted. A nonscheduled technique will be used for interviewing to afford the respondents ample opportunity to expound on problems they perceive with the issue. Information quality can be improved with this method through probing of the respondents with respect to their replies to the measurement questions.

Because this is an exploratory and descriptive analysis to determine the existence and extent of the problems created by biomonitoring, data analysis will entail reporting the results of the interviews and determining trends in results and/or consensus among the respondents about the problems. The objective will be to agglomerate the views of the experts in the field and operators of the facilities to determine the overall problems experienced or to be expected by DoD regarding biomonitoring. No statistical analysis of the data will be necessary because, although trends will be sought regarding problems, a certain percentage of the respondents identifying a specific problem will not be required to classify it as such. One individual may have some insight to some aspect of biomonitoring that is indeed a problem for DoD that no other respondents had considered. A lack of consensus will not preclude its inclusion in the analysis.

IV. Findings

Overview

This chapter presents the findings obtained through interviews of personnel from various military bases that have their own wastewater treatment facilities. Appendix C lists the points of contact at each base contacted. Bases that use regional connections to local Publicly Owned Treatment Works (POTWs) are not included. In this situation, the POTW has the responsibility to comply with all monitoring requirements in the NPDES permit. Additionally, results of interviews with people from DoD laboratories that conduct biomonitoring are also presented. Results from the bases will be divided into those from bases that are required to biomonitor and those that are not. A summary of the current biomonitoring requirements of the bases contacted is provided in Appendix B.

Bases Not Required to Biomonitor

For bases that treat their own wastewater, there were two situations where biomonitoring was not required: 1) the base had no NPDES permit; or 2) the base had a permit but the permit did not require biomonitoring.

Bases With No NPDES Permit. Several bases contacted treat their own wastewater but are not required to operate under a discharge permit. In these cases, the treated water is not discharged to any receiving body of water, but is

instead used for irrigation or left to evaporate and percolate into the ground from lagoons. MacDill AFB, FL, and March AFB, CA both use effluent to water base golf courses; March AFB also uses effluent to water the base cemetery. Marine Corps Base (MCB) 29 Palms, CA uses its effluent to water the parade grounds and trees on base. Reese AFB, TX has a 'Permit to Dispose of Wastewater' as opposed to a discharge permit. They use two playa lakes for their effluent; one for stormwater and runway runoff, and one for effluent from the wastewater treatment plant. This effluent is then used for irrigation of the golf course. The stormwater runoff evaporates and infiltrates into the ground.

Three Air Force bases currently use evaporation ponds for effluent disposal: Fairchild AFB, WA; Holloman AFB, NM; and Mountain Home AFB, ID. In all three cases, this method will be terminated and another method initiated within the next three to four years. Fairchild AFB is looking into a regional connection to a local POTW; Holloman and Mountain Home both have wastewater treatment plants in their budgets. NPDES permits will be required at both bases unless the effluent is reused rather than discharged.

The effluent from the wastewater treatment plant at Tyndall AFB, FL goes to a county lagoon where it is then treated by the county along with other county waste and then

discharged. Tyndall does have a discharge permit for their stormwater but no biomonitoring is required.

Sprayfields are most commonly used to dispose of effluent without discharging. A ranch near Laughlin AFB, TX uses the base's effluent for pasture irrigation, and the effluent from Cannon AFB, NM is used to irrigate grain crops raised for non-human consumption. MacDill AFB, FL, Eglin AFB, FL, and Castle AFB, CA also use sprayfields for effluent disposal.

Bases With NPDES Permit. Numerous bases do operate under a NPDES permit but are not required to have their effluent biomonitored on a recurring basis. Of these, several have had no indications that the state they are operating in will require biomonitoring in the future.

Eaker, KI Sawyer, Grissom, and Wurtsmith Air Force Bases all operate under expired permits and are waiting for new permits to be issued by their respective states. Of these, KI Sawyer will be required to pass one whole effluent toxicity test in order to obtain the new permit. Mr. Pete Sustridge, the wastewater treatment plant foreman, indicated that they are considered a small plant which may be the reason for the single test. He does not anticipate a problem passing the test since they currently discharge to a trout stream with no adverse impacts. Another possibility is that the state will use the single test to verify or demonstrate that the effluent does not have the potential to

adversely impact the water quality of the stream. Eaker, Grissom, and Wurtsmith Air Force Bases have had no indications that new permits will require biomonitoring.

Another base operating under an expired permit is Arnold AFB, TN. The current permit does not require biomonitoring, but the new permit will. Issues regarding the plans for biomonitoring will be addressed in the following section.

MCB Quantico, Marine Corps Air Station (MCAS) Beaufort, Moody AFB, Columbus AFB, and Scott AFB, all have state discharge permits and are not required to biomonitor. Only standard parameters such as dissolved oxygen, total suspended solids, biological oxygen demand, etc. are required to be analyzed. The permit for Scott AFB was renewed less than a year ago for four years with no biomonitoring requirement. The permit for Moody AFB was also renewed last year for five years with no mention of biomonitoring by the state. The other four bases have also had no indications that biomonitoring will be required with renewed permits.

Three bases contacted are in peculiar situations; Marine Corps Base Camp Lejeune, Grand Forks AFB, and Patrick AFB have no biomonitoring requirements in their permits, but all conduct, or have conducted, biomonitoring tests on their effluent. At Camp Lejeune, where seven separate permits are issued, the state of North Carolina required the base to

submit samples for biomonitoring. When the samples failed, the state required biomonitoring under an administrative letter. However, since biomonitoring is not required by any of the permits, a test failure does not result in a Notice of Violation (NOV). Grand Forks AFB does biomonitoring now for data collection purposes only. They will be required to pass biomonitoring tests by 1992. A third base in this type of situation is Patrick AFB, FL. Patrick has a state permit that does not require biomonitoring, however the EPA, required them to take one biomonitoring test in 1986-1987. The base passed the test and has not had to take the test since. A reapplication for their state permit has been submitted and there are no indications that biomonitoring will be required regularly with the new permit.

Williams AFB, AZ is in a situation similar to those bases without discharge permits. They have a permit and it does require biomonitoring when they discharge; however they have not discharged in the past two years. The effluent is used to water the golf course. They did increase the storage required to hold the excess effluent in the winter months, and came very close to having to discharge this past winter. Wastewater treatment plant operations are contracted, and it is the contractor's responsibility to have any biomonitoring tests performed in the event of a discharge.

As discussed above, there are ways to dispose of wastewater without being subject to NPDES requirements, including biomonitoring. Biomonitoring is however being implemented by some states; and with it come certain requirements and impacts on facilities that must use these tests.

Bases Required to Biomonitor

Several bases were contacted where biomonitoring of the wastewater effluent is required by discharge permits. Of those bases contacted, two ways of having the biomonitoring done were identified: contracted to a civilian laboratory; or done by Armstrong Laboratory at Brooks AFB, Texas. In some instances both methods were used. In no case was biomonitoring done by the base itself. The primary issues addressed regarding biomonitoring were cost, personnel, sampling, and plant operations. Biomonitoring of non-point sources, such as stormwater runoff, was also addressed.

Cost. Four bases contacted use Brooks AFB exclusively for their biomonitoring. Of these, Hill AFB must biomonitor quarterly, and Whiteman AFB must biomonitor annually. Robins AFB must biomonitor on demand from the state, and has only been required to do so once since 1988. The Environmental Engineer at Robins did not know if the next permit would require biomonitoring on a regular basis. Loring AFB, ME also has had to pass only one test in the past five years, although the state will probably require

quarterly testing with the next permit. The current permit expires in October 1991. The state has indicated that each quarterly test will probably be with one species of fish and that the species will be alternated between fathead minnows and trout. Loring has not addressed the trout testing with Brooks. If Brooks cannot conduct the trout tests, the base may look at testing on base or contracting the tests. In all cases, the only costs associated with testing at Brooks are those for sample shipment.

Two bases, Ellsworth AFB, and Beale AFB use both contracted labs and Brooks for their biomonitoring. The permit for Ellsworth AFB requires quarterly testing unless they fail, in which case monthly testing is required. Ellsworth has failed some tests and is therefore testing monthly. Ellsworth went to a contracted lab because Brooks was having some problems with the control specimens during the tests, rendering the tests invalid, and necessitating resubmittals of samples. The Base Environmental Coordinator at Ellsworth has indicated that they are not sure if the test failures were due to Brooks' procedures or to bad effluent. The base has passed the last two monthly tests since using the contracted lab. Costs for the contracted tests are $1100 per test for two species of organisms.

Beale AFB also has testing done at Brooks and a contracted lab. Mr. Miller, the base Water Quality Engineer indicated that it costs nothing to have testing done at

Brooks but there was some question about Brooks' certification by the state of California for wastewater testing. He also indicated that Brooks has had some problems with losing samples or results of tests. The costs of the contracted tests are $250 per test for a single species. Beale currently runs one test per quarter. The state will be requiring three species testing soon which will increase Beale's costs. Beale also disposes of 10 - 50% of its effluent without discharging (irrigation, etc.) and has discussed going to 100% reuse which would eliminate biomonitoring costs.

Contracting the biomonitoring tests to civilian laboratories was the most common method of having the tests done. Costs of the tests done through contracting varied widely; Table 1 summarizes the cost data from the bases contacted that contract biomonitoring tests.

The variability in costs of the tests is affected by the type of test run and the number of species of test organisms used. Chronic tests require much more time and labor to conduct and therefore cost much more. Also evident from Table 1 is the variability in types of tests required by different states.

Two other cases of contracted biomonitoring exist at Williams AFB, AZ, and Arnold AFB, TN. These two bases contract their wastewater treatment plant operations, wherein the government owns the plant and the operations are

contracted. Williams AFB (discussed above) has it written into the contract that if they must discharge, the contractor is responsible to have the biomonitoring tests done in accordance with the permit.

Table 1

Cost Comparison of Contracted Biomonitoring Tests

Base	Cost per Test ($)	Chronic or Acute	Number of Species	Frequency
Luke AFB	200	A	1	weekly
MCB Camp Lejeune	200	A	1	monthly
MCAS Cherry Point	250	A	1	quarterly
Beale AFB	250	A	1	quarterly
Grand Forks AFB	650	A	2	5-6 tests per year
Minot AFB	900	A	2	5-6 tests per year
Ellsworth AFB	1100	A	2	monthly
Shaw AFB*	1800	NA	NA	semi-annual
Tinker AFB	2000	C	2	monthly
Kelly AFB	2200	C	2	monthly

* - Shaw AFB is required to conduct in-stream bioassessments for water quality monitoring.

At Arnold AFB, they are operating under an expired permit. The new permit, when issued, will require biomonitoring. Conducting and passing the tests will be written into the contract for the wastewater treatment plant. The base has budgeted for this requirement.

Personnel. The personnel issue addressed was whether any extra personnel were hired by the bases as a result of biomonitoring requirements. Marine Corps Air Station Cherry Point, NC was the only base contacted that hired any additional personnel. An additional technician at the GS-3 level was hired to aid in handling the additional work created by the discharge permit. This was not due solely to the biomonitoring requirements. At all other bases, existing personnel were tasked to handle the sampling required for biomonitoring. The shop or section tasked to conduct the sampling varied from base to base. Generally personnel from the Bio-environmental Section, the Environmental Management Section under Civil Engineering, or personnel from the treatment plant did the sampling. Few personnel problems were encountered due to sampling.

Sampling. In no case were there any significant problems with sampling requirements or techniques. Once the procedure was established and implemented, it became another part of the "routine" of the personnel taking the samples. Minor problems associated with growing pains were reported by some bases. For example at MCB Camp Lejeune, three

samples became too warm on one occasion and had to be discarded and new samples submitted. Two bases, MCAS Cherry Point, and Hill AFB, reported some problems with obtaining samples because of outfalls that do not discharge continuously. At Cherry Point, difficulty in coordinating flows from the oil/water separator, used for industrial pretreatment, with the time periods required for sampling and testing was encountered. This problem was alleviated when the base stopped taking the discharge from the separator at the treatment plant. Hill AFB is only required to biomonitor two of five permitted discharges for non-point sources of pollution. These are streams or drainage ditches that collect stormwater runoff, etc. and exit the base. Oil and grease are monitored at all of the discharges. Of the two discharges that must have biomonitoring tests run, only one is continuously discharging. The permit requires the base to alternate streams sampled each quarter, however if the stream scheduled to be sampled and tested is not flowing, the sample is taken from the continuously flowing outfall.

Several bases have purchased computerized composite samplers to accommodate all of the sampling requirements of NPDES permits, including biomonitoring samples. In most cases, water samples for biomonitoring tests are taken in conjunction with samples required for other monitoring requirements such as chemical analyses, and other water

parameter testing (biological oxygen demand, total suspended solids, etc.).

Findings about sample shipping are similar to those for sample taking. Once procedures are established, it becomes part of normal operations. Funds for sample shipment typically come from operating and maintenance (O&M) funds of the treatment plant, or in the case of Loring AFB, from O&M funds of the Bio-Environmental section which falls under the hospital's operations. On bases where biomonitoring is contracted, the funds for shipping are usually part of the Blanket Purchase Agreement (BPA) or the contract.

Plant Operations. Plant operations have been impacted to some extent by biomonitoring requirements. At Luke AFB, the secondary treatment facility cannot effectively treat the industrial waste entering the plant. This has caused test failures which has led to weekly testing as stipulated in the discharge permit. An industrial waste treatment plant was in the planning stages before biomonitoring was initiated at the base, and some changes to the design have been implemented as a result of biomonitoring requirements.

A common problem causing biomonitoring test failures at treatment plants is chlorine residuals resulting from chlorination for disinfection of the effluent before final discharge. At Camp Lejeune, the Supervising Chemist in the Environmental Management Section indicated a Catch-22 situation in that reducing chlorination to obtain a level in

the effluent of 2 parts per million or less results in problems passing BOD and fecal coliform tests. They are currently looking into sulfur dioxide as an additional treatment step to neutralize the chlorine after disinfection. Beale AFB has also reported similar problems with chlorination. At Loring AFB, chlorination was added to correct problems with fecal coliform violations before biomonitoring was required. A dechlorination step, using sodium hydroxide, was instituted to counter the adverse effects of the chlorine in the receiving body of water. This has enabled them to pass the one biomonitoring test requested by the state in the past five years, and should provide quality effluent for future biomonitoring requirements. Tinker AFB removed chlorination all together which has improved the quality of the effluent. This, and other changes at the base (see below), has resulted in the base passing biomonitoring tests for the past four months. This is a case of saving a treatment step, and the cost of chlorination, to improve effluent quality with no concurrent problems with fecal coliform. Whiteman AFB has also stopped using chlorine to remove algae from the final outfall tank; algae are now removed manually.

Several bases reported other isolated problems with biomonitoring tests ranging from test procedures to other aspects of plant operations. Luke AFB indicated that a problem with pH adjustment was hindering tests. The pH

level of the effluent sample was changing in the time between sample taking and testing. The lab failed to adjust the pH to the level of the sample when it was taken. Once pH adjustment was undertaken, survival rate of the test species improved, though not enough to enable the effluent to pass the tests. MCAS Cherry Point shut off the discharge from an oil/water separator entering the waste stream before wastewater treatment. This is now collected and removed by the Defense Reutilization and Marketing Office. A similar change was made at Beale AFB before biomonitoring was implemented. Waste from the photo lab is no longer discharged to the normal waste stream for treatment. This cleared up a boron and cyanide problem at the treatment plant and has resulted in improved effluent quality. Another change at Tinker AFB resulting in improved effluent quality was the replacement of toxic cleaning compounds with organic compounds with no loss in cleaning effectiveness.

In all, plant operations do not seem to have been drastically impacted by biomonitoring requirements. Stormwater runoff and other non-point sources of pollution have similarly not been drastically impacted by these requirements.

Non-Point Sources

As indicated above, of the bases contacted, only Kelly and Hill Air Force Bases are required to biomonitor non-point sources of pollution. Ellsworth AFB expects the next

permit for non-point sources, to be issued during the summer of 1991, to require biomonitoring. It was not indicated whether the testing would be done by the lab at Brooks or through the contracted lab used for other biomonitoring. The other bases were not required to biomonitor non-point sources and either did not think biomonitoring would be required by future permits, or did not know. For example at Grand Forks AFB, a stormwater discharge permit is coming up but requirements for this discharge have not yet been established.

In addition to the impacts on specific bases, information about service wide biomonitoring impacts and issues was obtained by contacting biomonitoring labs within the Army and Air Force, and from two Engineering Field Divisions within the Navy Department.

AL/OEMB, Brooks AFB, TX

Armstrong Laboratory, Occupational Environmental Health Directorate, Occupational Medicine Division, Environmental Biology Branch (AL/OEMB) located at Brooks AFB, Texas does do routine bioassays, or biomonitoring, for Air Force bases. Capt Holck, Chief of the Ecology/Bioassay Function, stated that they currently conduct 200 - 250 bioassays per year for routine testing requirements for 15 - 20 bases. As indicated above, these routine tests can range from annual to weekly requirements, depending on the state and permit requirements involved. No testing is conducted for bases

outside of the Air Force. They can and do also assist bases in setting up contracts for testing through civilian laboratories. Capt Holck indicated that the lab is certified in the states of South Carolina, Oklahoma, and California, and that the EPA recognizes them as a qualified lab. The amount of work done by the lab can result in problems for some bases getting testing done when needed, but Capt Holck felt that this could be alleviated somewhat by proper coordination of testing requirements when possible. Another work-load problem they have is in conducting chronic 14 day tests. Each of these tests requires 300 man-hours to complete. Some bases requiring this test must therefore contract it.

Two bases, Hill and Ellsworth, indicated some problems with control sample survivability at Brooks. Ellsworth went to contracted testing as discussed above. Brad Christensen of the Environmental Management Section at Hill indicated that the state of Utah accepted the results from Brooks as long as the effluent samples passed at 100 percent concentration. This problem was acknowledged by Capt Holck. However he indicated that they have been working on the problem, and that they have as good a survivability rate for control specimens as the EPA laboratories.

A government estimate regarding the costs of conducting biomonitoring tests found that AL/OEMB can conduct the tests for approximately 50 percent of contracted costs for

testing. When asked about this cost savings and the work load problem, and whether another base should be equipped to conduct biomonitoring, Capt Holck indicated that he would rather see the facilities at Brooks expanded rather than set up another lab. He felt that since facilities are already established at Brooks, keeping the monitoring and testing functions centralized would be more beneficial than expanding to another base.

In addition to the routine testing, AL/OEMB also does Toxicity Reduction Evaluations (TRE) for bases with chronic toxicity problems, and monitors contracts for TREs when contract costs are $500,000 or more. Research in the bioassay arena is also conducted at the lab. They are currently working on real-time biomonitoring tests for war time applications, and long-term effects of effluent on samples of fish (tumor growth, etc.). This type of testing, and assistance for bases in biomonitoring contracts, are also the primary functions of two Army laboratories.

United States Army

The U.S. Army Biomedical Research and Development Laboratory at Fort Detrick MD is primarily focused on research and development related to biological monitoring. The only work done with individual Army bases is through a mobile biomonitoring trailer used to test effluent at various locations. This is used primarily for data collection and is not used for routine testing required in

permits. Much testing and research is being done on Rapid Toxicity Assessments and on the use of different test species such as frog embryos and bluegill fish for biomonitoring.

The US Army Environmental Hygiene Agency (AEHA) located at Aberdeen Proving Grounds (Edgewood) MD, does biomonitoring that is more in line with discharge permit requirements, however they also do not do any routine biomonitoring for Army bases. This lab does initial biomonitoring at bases to assess the waste stream and look for any potential problems, and they help bases in setting up contracts for routine biomonitoring. The aquatic biologist at this lab indicated that only two Army bases (that he could think of) biomonitor their own wastewater; most Army bases contract biomonitoring when it is required. A rough estimate of 25 percent of Army bases use regional connections to local POTWs.

Further along this trend of decentralized biomonitoring is the United States Navy.

United States Navy

Two of the seven Engineering Field Divisions (EFDs) were also contacted to assess biomonitoring impacts on Navy bases. Points of contact at both divisions indicated that biomonitoring is contracted when required by permits. The Navy differs from the other services in that most of their activities are coastal and their discharges go to the

saltwater environment as opposed to freshwater bodies. Mr. Wayne Olson of the wastewater treatment section of the Western Divisicn located in San Bruno California, indicated that all inland bases in northern California use evaporation ponds and therefore do not require discharge permits with their inherent monitoring requirements. All coastal activities discharge to the marine environment. A particular problem this creates is in testing species of fish that live in a saltwater environment with freshwater effluent. Mr. Olson indicated that the stickleback fish is used because it can live in a fresh or saltwater environment if given time to adjust to differing salinity levels. Biomonitoring tests are conducted on fish raised in freshwater on the theory that adverse impacts on this type of fish will also affect saltwater species. Mr. Tim Rhodes in the Water Resources Management Section of the Southern Division indicated that saltwater fish can also be used for biomonitoring if the salinity of the effluent samples is adjusted to approximate that of the receiving body of water. Tests used by bases in the Western Division include a Percent Survival Test, using undiluted effluent, and a Lethal Concentration 50 (LC50) test using various dilutions of the effluent. Contracted costs of these tests range from $140 for the Percent Survival to $180 for the LC50 per test. A third test being addressed for permits is an algae test. Similar to tests with fish, this test will assess the

impacts of the wastewater effluent on algae growth. A government estimate of the cost for this type of test is $500 per test, while a contractor's estimate was given as $900 per test. Particulars of this type of test, and future permit requirements regarding it, are beyond the scope of this project.

V. Conclusions and Recommendations

The overall objective of this research effort was to assess the impacts of biomonitoring requirements as written into NPDES permits upon DoD wastewater treatment facilities. With the advent of increasingly restrictive discharge limits and monitoring techniques being developed by the EPA and states administering water quality programs, NPDES permit holders must attempt to stay on top of, or one step in front of, regulatory requirements. The Department of Defense in particular must not fall behind in this endeavor. As the Secretary of Defense stated in a memorandum to the Secretaries of the military departments:

> We [the Department of Defense] must demonstrate commitment with accountability for responding to the Nation's environmental agenda. I want every command to be an environmental standard by which Federal agencies are judged. (17:1)

This chapter will summarize the findings obtained with respect to the investigative questions posed in chapter I, and posit some recommendations for future actions regarding wastewater treatment and monitoring. Finally, some possible areas for future research and analysis will be presented.

Conclusions

Question One. The first question addressed whether individual DoD facilities had the capabilities to conduct biomonitoring on site in accordance with the regulations and test procedures. None of the bases contacted (Air Force and

Marine Corps) had this capability. Personnel from the Navy Engineering Field Divisions also indicated that no Navy bases have the capability to conduct on-site biomonitoring; a respondent from the Army indicated that only two Army bases conduct on-site biomonitoring. When personnel at the bases were asked if biomonitoring could be done at their bases, cost and adequately trained personnel were most often cited as prohibitive factors to on-site testing. A lack of adequate testing facilities and the cost of building/ installing such facilities was another factor mentioned by some of the respondents.

Question Two. The second question dealt with cost effectiveness of having the tests done within the Department of Defense or having them contracted to civilian laboratories. With on-site testing all but ruled out, the options left to Air Force bases are to have the biomonitoring done at AL/OEMB located at Brooks AFB, or to have them contracted. None of the other services have a centralized laboratory capable of conducting routine biomonitoring for permit compliance. For the other services then, cost-effectiveness at the base level is not currently an issue as contracting is the only method for biomonitoring. For the Air Force, Brooks AFB estimates that it can run biomonitoring tests for roughly 50% of the cost charged by contractors. Additionally, costs for biomonitoring come out of the budget for AL/OEMB, hence

bases that use this facility to conduct biomonitoring incur shipping costs only. This cost advantage for the bases can however be offset by a loss in efficiency of getting test results in a timely manner due to excessive work loads at Brooks. Lost samples and control sample survivability, as indicated by Ellsworth AFB, Beale AFB, et al., have also caused some problems for bases using Brooks. Therefore, in some situations, although Brooks may be the most cost-effective facility to do biomonitoring for Air Force installations, it may not be the best option.

Question Three. Taking samples of the wastewater effluent, and specific requirements for storage and shipping, was another anticipated problem area for DoD facilities. There were no significant problems with sample-taking identified by any of the bases contacted. In no case were additional personnel hired for additional sample-taking requirements due solely to biomonitoring, nor was any special training for existing personnel required. Shipping and handling restrictions, specifically getting samples to the laboratory on time and maintaining proper temperatures, also posed no significant problems for the bases. Once procedures were established at the bases for sample-taking and shipment, this function became a part of normal operating procedures for the section or sections tasked to accomplish it. Some bases did report some minor "growing pains" with the new sampling requirements. However, such

initial problems can be associated with almost any newly implemented procedure.

Question Four. The final question addressed did reveal that some DoD facilities were having problems producing effluent capable of passing biomonitoring tests. Again however, this was not a wide-spread problem among the bases contacted. Several bases contacted are currently conducting biomonitoring tests on a more frequent basis than would be required if their effluent passed the biomonitoring tests. These bases are either undergoing toxicity reduction evaluations, or are awaiting funds for construction or modification of treatment facilities. Other bases have made some modifications to plant operations so as to enable them to pass biomonitoring tests.

General Conclusions. Overall, biomonitoring has not adversely affected DoD wastewater treatment operations to the degree anticipated at the start of this research project. The overriding factor leading to this conclusion is the number of bases contacted that do not have biomonitoring written into their discharge permits. Additionally, most of the personnel contacted at bases where biomonitoring is not required, all of whom were knowledgeable about the permitting process and requirements for their base, had heard no mention from their respective states about biomonitoring. These two factors indicate that either the states had not gotten around to implementing

biomonitoring requirements, or had determined that these facilities had no potential to cause excursions of state narrative water quality criteria.

For bases where biomonitoring is required, the one major problem area encountered is cost. Costs of the contracted tests were found to vary depending on the contracted laboratory and the type of test required by the permit. This cost can only be viewed as one of the inevitable prices to pay for using the environment as a receptor of waste products.

Recommendations

Environmental legislation and regulations will not become less stringent as time goes on. Indeed, the opposite will no doubt be the case. Efforts to maintain and improve the quality of the nation's waterways will continue; treatment methods and monitoring of water quality will become increasingly sophisticated and restrictive, and additional sources of pollution will be targeted. Although significant adverse impacts were not found at DoD installations due to biomonitoring, several actions could be taken at the base level and the service level to reduce future impacts due to biomonitoring.

DoD Laboratories. The U.S. Air Force should conduct a feasibility study to determine if expanding the facilities at AL/OEMB at Brooks AFB would be cost effective. Since the capability to conduct biomonitoring exists, and since the

laboratory is recognized as a qualified lab by the EPA, expanding the lab to accommodate more of the routine testing needed by Air Force bases may prove cost effective by alleviating the need for bases to contract the tests. Similar feasibility studies could also be conducted by the other services to determine the cost-effectiveness of establishing facilities to conduct routine biomonitoring for their bases. Other monitoring requirements that may arise in the future, stormwater testing for instance, should also be considered.

Effluent Disposal. At the base level, environmental coordinators and managers should look into methods of effluent disposal that do not require discharging to a receiving body of water. This was the situation for many of the bases contacted that treat their own wastewater. If an environmentally sound method of effluent disposal can be instituted, all problems associated with NPDES permits, administrative and regulatory, can be alleviated. Additionally, this method of disposal, if used for irrigation, negates the use of potable water for watering grass on the base. This course of action will not be feasible at all bases, especially those in temperate climates; bases in arid or semi-arid climates however should not overlook this possibility.

Operations at the Bases. DoD bases should also look at specific operations that may be adversely affecting

wastewater treatment and effluent quality. Modifications to, or collection of waste from, these processes should be addressed with improved effluent quality as the goal. Several bases have benefitted from this type of analysis as discussed in Chapter IV.

Prepare for the Future. Bases that have NPDES permits but are not required to biomonitor the effluent should take a proactive course of action and have their effluent tested by Brooks to determine if it could in fact pass the tests. For bases that have heard nothing about biomonitoring, the assumption that it may be required in the future would be prudent. By determining beforehand if their effluent has the potential to be toxic to biota, steps could be taken to correct any problems before regulatory action is needed. This would also be seen by the state as a good-will effort by the base in conducting tests not as yet required. Additionally, if a data base can be established showing that the effluent from the base is non-toxic, this could help in negotiating monitoring requirements of future permits.

The above proactive course of action should also be taken by all DoD bases with regard to stormwater. Laws and regulations regarding this source of pollution are currently being implemented, and being prepared for state implementation can only benefit DoD installations.

The findings of this research effort have also identified some possible future research questions in the wastewater treatment arena.

Future Research

Research into each state's water pollution control agendas would provide useful information to bases within those states as to what to expect in the future. Questions that might be addressed include 1) will narrative criteria and the monitoring requirements for compliance become more stringent; and 2) can bases that currently biomonitor expect the third control method of the EPA's integrated approach, bioassessments and biosurveys, to be required in future permits in addition to chemical analysis and whole effluent toxicity testing (biomonitoring)?

Feasibility studies of wastewater reuse at specific bases, if not already undertaken, could also prove useful to those bases and the Department of Defense. Questions to address would include cost effectiveness and climate/ geologic suitability.

Finally, research into the effectiveness and results of toxicity reduction evaluations of bases encountering toxic pollution problems would provide information on DoD's progress on pollution prevention. This would also provide other bases with similar toxicity problems information on possible corrective measures.

Appendix A: Interview Questions

Treatment Works Operators/Managers
Base/Location:
Name/Point of Contact: **Title:**
Phone Number: (AV): **Comm:**
Address:

NPDES Permit:

1. Industrial or Domestic Treatment?

2. Expiration of current permit?

3. Does current permit require biomonitoring?

   If No - go to question 21 and 26.

   If Yes:
   4. How long has biomonitoring been required?

   5. Where is biomonitoring done (on base, another base, or contracted)?

   If done by military:
   6. Point of Contact and location?

   7. What are the costs of the lab; what sort of training was required?

   8. Would it be better to contract (cost; personnel; etc.)?

   If contracted:
   9. Point of contact for information on contract?

   Name: Phone:
   * see questions on contract.

   10. Where is the testing done (local area?)?

   11. Could it be done on base? Would it be cheaper?

Sample Collection:

12. Who does sample collection (military or civilian personnel)?

If civilian:

13. Hired for that job or collateral duty?

14. GS level?

If military:

15. Grade?

16. Have there been problems with sample collection/shipment?

    a. time delays; missing deadlines?

    b. storage problems?

    c. restrictive sampling techniques posed in permit (locations; flow amounts)?

17. Where do funds for shipping come from?

General:

18. What is the mix of military/civilian personnel?

19. Have there been any test failures?

If yes:

19a. Were problems easily correctable?

20. Were any changes in plant operations needed to enable effluent to pass biomonitoring tests?

21. Were there permit violations before biomonitoring was required?

22. Has biomonitoring resulted in improved quality of the effluent due to any changes made?

23. Has biomonitoring hindered or burdened treatment works operations?

Other:

24. Does permit require biomonitoring of non-point sources (drainage ditches; surface runoff; etc.)?

If yes:

25. What problems, if any, has this created (sampling; passing test; etc,)?

If NPDES permit does not require biomonitoring:

26. Do you expect next permit to require biomonitoring?

If yes:

27. Have plans been made for conducting the tests?

a. Sampling:

28. Who will sample?

29. How will samples be shipped?

b. Testing:

30. Where?

31. Would you like to see it done in-house (DoD) or contracted? Why?

32. Any changes anticipated in light of biomonitoring requirements?

If no to question 25:

33. Why?

Contract:

34. Is it a service contract?

35. What is cost of the contract?

36. How long does the contract run?

Comments:

Appendix B: Biomonitoring Requirements of Bases Contacted

Base	NPDES Permit (Y/N)	Biomonitoring Required (Y/N)	Biomonitoring Done By: DoD	Contracted	Both
Cannon AFB	N				
Castle AFB	N				
Eglin AFB	N				
Fairchild AFB	N				
Holloman AFB	N				
Laughlin AFB	N				
MacDill AFB	N				
March AFB	N				
MCB 29 Palms	N				
Mountain Home AFB	N				
Reese AFB	N				
Arnold AFB	Y	N			
Columbus AFB	Y	N			
Eaker AFB	Y	N			
Grand Forks AFB	Y	N			
Grissom AFB	Y	N			
KI Sawyer AFB	Y	N			
MCAS Beaufort	Y	N			
MCB Quantico	Y	N			
Moody AFB	Y	N			
Patrick AFB	Y	N			
Scott AFB	Y	N			
Tyndall AFB	Y	N			
Wurtsmith AFB	Y	N			

Base	NPDES Permit (Y/N)	Biomonitoring Required (Y/N)	Biomonitoring Done By: DoD	Contracted	Both
Beale AFB	Y	Y		X	
Ellsworth AFB	Y	Y			X
Hill AFB	Y	Y	X		
Kelly AFB	Y	Y		X	
Loring AFB	Y	Y	X		
Luke AFB	Y	Y		X	
MCAS Cherry Point	Y	Y		X	
MCB Camp Lejeune	Y	Y		X	
Minot AFB	Y	Y		X	
Robins AFB	Y	Y	X		
Tinker AFB	Y	Y		X	
Whiteman AFB	Y	Y	X		
Williams AFB	Y	Y		X	
Shaw AFB	Y	Y*		X	

* Shaw AFB uses in-stream bioassessment.

Appendix C: Points of Contact at Bases Contacted

Base: Arnold AFB, TN
POC: Bill Dunne
Title: Director, Environmental Planning
ph: (AV) 340-4345

Base: Beale AFB, CA
POC: Greg Miller
Title: Water Quality Engineer
ph: (AV) 368-2641

Base: Cannon AFB, NM
POC: Sid Rollinson
Title: Superintendent, Wastewater Treatment Plant (WTP)
ph: (AV) 681-2379

Base: Castle AFB, CA
POC: Mr. Chan
Title: Environmental Engineer
ph: (AV) 347-4841

Base: Columbus AFB, MS
POC: MSgt Federoff
ph: (AV) 742-2285

Base: Eaker AFB, AK
POC: Eddie Tucker
Title: WTP Foreman
ph: (AV) 721-5422
POC: Capt Merryman
Title: Bioenvironmental Engineer
ph: (AV) 721-7470

Base: Eglin AFB, FL
POC: Julie Murie-Catone
Title: Wastewater Resources
ph: (AV) 872-4435

Base: Ellsworth AFB, SD
POC: Clara Daggett
Title: Environmental Coordinator
ph: (AV) 675-2523

Base: Fairchild AFB, WA
POC: Arnold Sather
Title: WTP Employee
ph: (AV) 657-2401

Base: Grand Forks AFB, ND
POC: Wayne Koop
Title: Chief, Environmental Branch
ph: (AV) 362-4590
POC: Gary Racknerud
ph: (AV) 362-6154

Base: Grissom AFB, IN
POC: Marlene Seneca
Title: Environmental Engineer
ph: (AV) 928-4579

Base: Hill AFB, UT
POC: Brad Christensen
Title: Environmental Management
ph: (AV) 458-6918

Base: Holloman AFB, NM
POC: Capt Emerson
Title: Bioenvironmental Engineer
ph: (AV) 867-7810/1

Base: Kelly AFB, TX
POC: 2ndLt Carroll
Title: Bioenvironmental Engineering
ph: (AV) 945-4041

Base: KI Sawyer AFB, MI
POC: Pete Sustridge
Title: WTP Foreman
ph: (AV) 472-2484

Base: Laughlin AFB, TX
POC: Mr. McElhanan
Title: Shop Foreman, WTP
ph: (AV) 732-5645/5501

Base: Loring AFB, ME
POC: Darrell Cullins
Title: CE - Environmental
ph: (AV) 920-2257

Base: Luke AFB, AZ
POC: Bill Melosche
Title: Wastewater Engineer
ph: (AV) 853-6394

Base: MacDill AFB, FL
POC: Gene Svitak
Title: WTP Foreman
ph: (AV) 968-5422

Base: March AFB, CA
POC: Mr. Hernandez
Title: WTP Employee
ph: (AV) 947-4172

Base: MCAS Beaufort, SC
POC: David Brown
Title: Utilities Supervisor
ph: (AV) 832-7539/6511

Base: MCAS Cherry Point, NC
POC: Glen Hartzog
Title: WTP Operator
ph: (AV) 582-2520

Base: MCB Camp Lejeune
POC: Elizabeth Betz
Title: Supervising Chemist, Environmental Management
ph: (AV) 484-5977

Base: MCB Quantico, VA
POC: Nina Proctor
Title: Utilities Engineer
ph: (AV) 278-2065

Base: MCB 29 Palms, CA
POC: Frank Geiger
Title: Facilities Maintenance Officer (Acting)
ph: (AV) 957-6268

Base: McClellan AFB, CA
POC: Larry Button
Title: Compliance Division
ph: (AV) 633-2517

Base: Minot AFB, ND
POC: Capt Churchill
Title: Environmental Engineer
ph: (AV) 453-4824

Base: Moody AFB, GA
POC: Mr. Crenshaw
Title: Chief, Environmental Contract Plans Section
ph: (AV) 460-3069

Base: Mountain Home AFB, ID
POC: John Hale
Title: Head, Environmental Office
ph: (AV) 857-6351

Base: Patrick AFB, FL
POC: Larry Smith
Title: Environmental Planning
ph: (AV) 854-7288

Base: Reese AFB, TX
POC: 1stLt Thomas
Title: Environmental Coordinator
ph: (AV) 838-3914

Base: Robins AFB, GA
POC: Shawn Polatino
Title: Environmental Engineer
ph: (AV) 468-9777

Base: Scott AFB, IL
POC: Tim Tedesco
Title: Environmental Protection Specialist
ph: (AV) 576-5763

Base: Shaw AFB, SC
POC: Maj Hayes
Title: Bioenvironmental Engineer
ph: (AV) 965-3682/2859

Base: Tinker AFB, OK
POC: Carol Cowan
Title: WTP Chemist
ph: (AV) 884-3892

Base: Tyndall AFB, FL
POC: Ms. Shell
Title: Environmental Engineering
ph: (AV) 523-4354

Base: Vance AFB, OK
POC: Max Cumpston
Title: Environmental Planning
ph: (AV) 962-7112

Base: Whiteman AFB, MO
POC: Capt Barnes
Title: Bioenvironmental Engineer
ph: (AV) 975-2251

Base: Williams AFB, AZ
POC: Capt Watson
Title: Chief, Environmental Contract Planning
ph: (AV) 474-6870

Base: Wurtsmith AFB, MI
POC: MSgt Smith
Title: Superintendent of Facilities
ph: (AV) 623-6796

BIBLIOGRAPHY

1. Blum, Diane J. W. and R. E. Speece. "Determining Chemical Toxicity to Aquatic Species," Environmental Science and Technology, 24: 284-293 (March 1990).

2. Boyd, Gail B. "The New Federal Stormwater Regulations," Public Works, 122: 63-67+ (February 1991).

3. Cairns, John Jr. and W. H. van der Schalie. "Biological Monitoring Part I - Early Warning Systems," Water Research, 14, No. 9: 1179-1196 (1980).

4. Cairns, John Jr. and David Oros. "Ecological Consequence Assessment," Ecological Engineering: An Introduction to Ecotechnology, edited by William J. Mitsch and Sven Erik Jorgensen. New York: John Wiley and Sons, Inc., 1989.

5. Committee on Armed Services, Environmental Restoration Panel, House of Representatives. Overview of DOD Environmental Activities. Hearings, 101st Congress, 1st Session.

6. Environmental Protection Agency. "Part 122 - EPA Administered Programs: The National Pollutant Discharge Elimination System," Code of Federal Regulations, Title 40, Parts 100 to 149: 58-114. Washington DC: Government Printing Office, 1990.

7. Environmental Protection Agency. Project Summary: Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, Second Edition. EPA/600/S4-89/001. Cincinnati: Environmental Systems Laboratory, March 1990.

8. Environmental Protection Agency. Technical Support Document for Water Quality-Based Toxics Control. EPA/505/90-001, PB91-127415. Washington DC: USEPA, March 1991.

9. Government Accounting Office. Water Pollution-Stronger Enforcement Needed to Improve Compliance at Federal Facilities (or Federal Compliance With Clean Water Act). GAO/RCED-89-13. Washington DC: Government Printing Office, December 1988.

10. Grimes, Max M. "The Impact of EPA's Biomonitoring Policy on POTWs," Journal Water Pollution Control Federation, 59: 755-760 (August 1987).

11. Hren, Janet and others. "Regional Water Quality; Evaluation of Data for Assessing Conditions and Trends," Environmental Science and Technology, 24: 1122-1127 (August 1990).

12. Lillie, Major Thomas H. "Aquatic Biomonitoring: Putting the "E" Back in EPA," Proceedings of the 16th Environmental Symposium: "Environmental Compliance and Enforcement at DOD Installations". October 1988.

13. Matthews, Robin A. and others. "Biological Monitoring Part IIA - Receiving System Functional Methods, Relationships and Indices," Water Research, 16, No. 2: 129-139 (1982).

14. Michael, Gene Y. and others. "Colorado's Biomonitoring Regulation: A Blueprint for the Future," Journal Water Pollution Control Federation, 61: 304-309 (March 1989).

15. Oakley, Monica M. and Carol L. Forrest. "The Clock is Ticking to Comply with New Stormwater Regulations," Water Environment & Technology, 3: 51-56 (March 1991).

16. Renaud, Capt Vincent E. Water and Wastewater Treatment Inventory and the Perceptions of Wastewater Engineers on Considerations Affecting Treatment Alternatives. MS Thesis, AFIT/GEM/DEM/87S-20. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1987 (AD-A188105).

17. Secretary of Defense. Memorandum for Secretaries of the Military Departments, Subject: Environmental Management Policy. Washington: The Secretary of Defense, 10 October 1989.

18. U.S. Congress. "Federal Water Pollution Control Act Amendments of 1972." Public Law No. 500, 92nd Congress, 2d Session. United States Statutes at Large, 86: 816-903. Washington DC: Government Printing Office, 1973.

19. U.S. Congress. "An Act to Amend the Federal Water Pollution Control Act to Provide for Additional Authorizations, and for Other Purposes." Public Law No. 217, 95th Congress, 1st Session. United States Statutes at Large, 91: 1566-1611. Washington DC: Government Printing Office, 1980.

20. U.S. Congress. "An Act to Amend the Federal Water Pollution Control Act to Provide for the Renewal of the Quality of the Nation's Waters, and for Other Purposes." Public Law No. 4, 100th Congress, 1st Session. United States Statutes at Large, 101: 7-90. Washington DC: Government Printing Office, 1989.

21. Wall, Thomas M. and Rebecca W. Hanmer. "Biological Testing to Control Toxic Water Pollutants," Journal Water Pollution Control Federation, 59: 7-12 (January 1987).

Vita

Captain James R. Brady was born on 6 October 1963 in Williamsport, Pennsylvania. He graduated from the Williamsport Area High School in 1981. He then attended the Pennsylvania State University where he received the degree of Bachelor of Science in Civil Engineering in 1985. Upon graduation, he was commissioned a Second Lieutenant in the United States Marine Corps. In November 1985 he attended training in the HAWK missile system at the US Army Air Defense Artillery Command at Fort Bliss, Texas. He was then stationed with the Second Light Anti-Aircraft Missile Battalion, MCAS Yuma, Arizona, where he served as a Firing Platoon Commander, Assistant Logistics Officer, and Battery Executive Officer. His next assignment will be as the Base Facilities Maintenance Officer at Marine Corps Base 29 Palms, California.

Permanent Address: RD#2 Box 12
Williamsport, PA 17701

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 1991	Master's Thesis

4. TITLE AND SUBTITLE

IMPACTS OF BIOMONITORING REQUIREMENTS ON DOD WASTEWATER TREATMENT FACILITIES

5. FUNDING NUMBERS

6. AUTHOR(S)

James R. Brady, Captain, USMC

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Air Force Institute of Technology, WPAFB OH 45433-6583

8. PERFORMING ORGANIZATION REPORT NUMBER

AFIT/GEM/DEV/91S-2

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

Legislative emphasis on reducing the toxicity of wastewater effluent has resulted in increasingly sophisticated methods of determining toxicity. The purpose of this research project is to assess the impacts on DoD wastewater treatment facilities of one new monitoring method, biomonitoring.

Biomonitoring has impacted DoD wastewater treatment facilities, however not to the degree anticipated. For bases that have been impacted, cost of contracting the tests is the primary problem associated with biomonitoring.

Many bases have not been impacted because wastewater reuse has negated the need for discharge permits, and the inherent monitoring requirements. Bases subject to biomonitoring should assess water reuse as a means of wastewater disposal. Additionally, other bases have not as yet had biomonitoring requirements imposed on them. It is recommended that these bases prepare for future biomonitoring requirements by having their effluent tested to determine toxicity in anticipation of biomonitoring implementation by the states.

Because the government can conduct biomonitoring tests at an estimated 50 percent of the contracted costs, it is also recommended that the Air Force assess the feasibility of expanding the capabilities at Brooks AFB.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Wastewater, Effluents, Biological Monitoring, Water Quality, Water Treatment	79
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

AFIT Control Number AFIT/GEM/DEV/91S-2

AFIT RESEARCH ASSESSMENT

The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. Please return completed questionnaires to: AFIT/LSC, Wright-Patterson AFB OH 45433-6583.

1. Did this research contribute to a current research project?

   a. Yes b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?

   a. Yes b. No

3. The benefits of AFIT research can often be expressed by the equivalent value that your agency received by virtue of AFIT performing the research. Please estimate what this research would have cost in terms of manpower and/or dollars if it had been accomplished under contract or if it had been done in-house.

   Man Years _____ $_____

4. Often it is not possible to attach equivalent dollar values to research, although the results of the research may, in fact, be important. Whether or not you were able to establish an equivalent value for this research (3 above), what is your estimate of its significance?

   a. Highly Significant b. Significant c. Slightly Significant d. Of No Significance

5. Comments

Name and Grade Organization

Position or Title Address